Designing a Safer Battery for Smartphones (That Won't Catch Fire)

By JOHN MARKOFFDEC. 11, 2016

"Using information from the article, and previous learning, write a few paragraphs persuading a perspective investor why battery research is an important endeavor."

Photo

Mike Zimmerman at his lab in Woburn, Mass. Credit Tony Luong for The New York Times

SAN FRANCISCO — Mike Zimmerman likes to shock his guests by using a hammer to drive a nail through a solid polymer lithium metal battery.

Nothing happens — and that's a good thing.

Mr. Zimmerman's battery is a new spin on lithium-ion batteries, which are widely used in products from smartphones to cars. Today's lithium-ion batteries, as anyone who has followed Samsung's recent problems with flammable smartphones may know, can be ticking time bombs. The liquids in them can burst into flames if there is a short circuit of some sort. And driving a nail into one of them is definitely not recommended.

With that in mind, Mr. Zimmerman's demonstration commands attention.

His Woburn, Mass., start-up, Ionic Materials, is at the cutting edge of an effort to design safer batteries. The company is working on "solid" lithium polymer batteries that greatly reduce their combustible nature.

A solid lithium polymer metal battery — when it arrives commercially — will also allow electronics designers to be more creative, because they will be able to use a plasticlike material (the polymer) that allows smaller and more flexible packaging and requires fewer complex safety mechanisms.

After four years of development, he believes he is nearly there and hopes to begin manufacturing within the next two years. Ionic Materials is one of a new wave of academic and commercial research efforts in the United States, Europe and Asia to find safer battery technologies as consumers demand more performance from phones and cars.

In the last year, Seeo and Sakti, rival United States solid polymer battery makers, have been acquired by the German industrial firm Bosch and the British vacuum maker Dyson.

The interest in solid batteries was highlighted in September when the United States Department of Energy's agency for supporting research in next-generation energy technology, announced 16 awards aimed at accelerating development of solid battery technologies, including a $3 million contract to Ionic Materials.

There is growing evidence that after decades of excruciatingly slow development, batteries are on the verge of yielding to a new generation of material science.

Historically, batteries have been a glaring exception to the exponential progress of made-by-computer processing and storage. In the last 150 years, in fact, only a handful of rechargeable battery chemistries have reached mass adoption.

"It's a huge challenge," said Ilan Gur, director of Cyclotron Road, a project to support energy-related innovators at Lawrence Berkeley National Laboratory in Berkeley, Calif. "The improvements in batteries happen very slowly, and the improvement of battery chemistry is very hard."

He points to disappointments with batteries going back more than a century.

Thomas Edison voiced his frustration at the technology in an interview in 1883: "The storage battery is one of those peculiar things which appeal to the imagination, and no more perfect thing could be desired by stock swindlers than that very selfsame thing."

Photo
Solid polymer lithium metal batteries that Mr. Zimmerman had repeatedly stabbed. Credit Tony Luong for The New York Times

Modern consumer electronics designers are not a great deal more optimistic.

"The only real breakthrough battery technology I've seen during my career was lithium-ion batteries, 18-plus years ago," said Tony Fadell, an electrical engineer who led the design of the iPod and original iPhone at Apple before founding Nest, the maker of home thermostats. "Sometimes it feels like a Captain Ahab-like quest."

Lithium-ion batteries, introduced commercially in 1991 by Sony, offered a significant advantage over existing nickel-cadmium rechargeable batteries in terms of compactness and rechargability.

But they also have the potential for failures that on two occasions have forced the consumer electronics industry into broad recalls. Sony had a series of problems with battery fires beginning in 2000, culminating in the recall of 4.2 million laptop batteries in 2006 — at the time the largest consumer electronics recall to date.

This fall, the recall of Samsung's Galaxy Note 7, a high-end smartphone, brought flammable batteries back into the news. Customers around the world reported that the phones were catching fire. Why it was happening is still unclear. A Samsung spokeswoman said that the company had not completed its evaluation of what led to the battery failures.

Many battery specialists say they believe that the failure lies in the South Korean electronics companies' desire to create a thinner battery package, leading to the design of an ultrathin separator, a safety feature intended to prevent battery electrodes from contacting each other directly. That could create a short circuit, leading to fire or explosion.

This use of liquid electrolytes is an inherent, potential flaw in lithium-ion batteries. They are based on liquid electrolytes, a material used to ensure the movement of ions, or charged particles, between the electrodes as the batteries are charged and discharged.

For more than a decade, a hunt has been underway for an alternative solid material that would be less volatile. There has been optimism about new solid polymers that might replace liquid electrolytes, but they have not moved to commercialization — with the exception of a lithium polymer battery now being used by Bolloré, the French electric carmaker.

But that technology is aimed at electric car batteries and it does not operate at room temperature — it requires preheating to roughly 192 degrees — something that has been true for virtually all of the lithium metal polymer batteries to date.

Room temperature operation is just one of the potential advantages claimed by Ionic Materials. Its new polymer also has the ability to shuttle ions between a battery cathode and electrode as efficiently as is currently achieved by liquid electrolytes, or even more efficiently.

Mr. Zimmerman's background is in the world of semiconductors; he worked at Bell Labs and then a company called Quantum Leap Packaging. Several university researchers who have worked with the company believe that has lead him to a technology that will be more manufacturable than competing polymer and ceramic battery technologies now being explored.

"What is so intriguing about Mike and his folks is they are using known production techniques borrowed from the semiconductor packaging industry," said Jay Whitacre, a Carnegie Mellon University physicist who was involved with Ionic Materials when it first started and who now is chief scientist at Aquion Energy, a maker of home storage and industrial batteries based in Mt. Pleasant, Pa.

The new progress has led a number of technologists in the field to believe that batteries may finally be getting out of their rut.

"We're in a golden age of new chemistry development which probably hasn't been seen in thirty or 40 years, since the last energy crisis," said Paul Albertus, a program manager at the Department of Energy's Advanced Research Projects Agency-Energy. "It's a pretty exciting time to be developing energy storage technology."